



noaa's ecological forecasting

Protecting Human Health and Coastal Economies with Early Warnings

Predicting Ecological Changes

The health of our coastal communities, economy, and ecosystems depend upon our understanding of complex and constantly changing conditions. Hazards such as pollution, extreme weather events, and climate variability are daily realities for the growing number of Americans who live in U.S. coastal shoreline counties. At NOAA, we're taking proactive steps to prepare for future conditions to help our nation become more resilient.

What is ecological forecasting?

An ecological forecast predicts changes in ecosystems and ecosystem components in response to an environmental driver such as climate variability, extreme weather conditions, pollution, or habitat change. It also provides information about how people, economies, and communities may be affected. Local authorities and members of the public use these early warnings to make decisions to protect the health and well-being of a particular area.

For example, Harmful Algal Blooms (HABs), popularly known as “red tides,” have caused a cumulative economic loss exceeding \$1 billion over the last two decades. HABs along the shore can cause illness and death in humans, fish, and marine mammals. HAB forecasts provide information that local authorities can use to decide whether a beach needs to be closed temporarily to protect public health.



People

Ecological forecasts protect people. Ecoforecasting efforts supported the University of Maryland with a medical diagnosis of a *Vibrio vulnificus* infection contracted from the Chesapeake Bay during a HAB event.



Economies

Ecological forecasts protect the economy. The health consequences of marine-borne pathogens cost our nation about \$900 million annually. The ability to forecast toxins allows coastal managers to close beaches and seafood harvesting in a timely manner so that costly illnesses are avoided.



Ecosystems

Ecological forecasts protect ecosystems. Responding to marine animal mortality resulting from HAB-related events in Florida and California has enabled NOAA scientists and partners to better understand long-term trends in HAB impacts across seasons, years, and geographical regions. Such information also provides “baseline” toxin values to compare to future HAB events.



In creating NOAA in 1970, President Nixon recognized the need for a holistic, integrated approach to earth science:

“We face immediate and compelling needs for better protection of life and property from natural hazards, and for a **better understanding of the total environment--an understanding which will enable us more effectively to monitor and predict its actions....**we already have the scientific, technological and administrative resources to make an effective unified approach possible. What we need is to bring them together. Establishment of NOAA would do so.”

NOAA's Role in Ecological Forecasting

How is NOAA uniquely positioned to deliver ecological forecasting?

NOAA has a long history in environmental forecasting. We forecast weather, climate, tides, fishery stocks, and recovery of protected species. We also have exceptional modeling and computing capacities and are at the forefront of development and use of new environmental sensors. A massive amount of NOAA weather, climate, oceanographic, coastal, and biological data supports these efforts.

For more than a decade, NOAA has been developing experimental forecasts in areas such as harmful algal blooms, pathogens, hypoxia, sea level change, wave energy, and ocean acidification. In a few cases, NOAA has transitioned the experimental forecasts into operations. For example, NOAA produces operational Harmful Algal Bloom forecasts for the Gulf of Mexico. These forecasts are based on satellite imagery, models, and field data from federal, state, and local monitoring programs; research vessels; buoys; and autonomous underwater vehicles. Combining this information allows NOAA to alert officials of the location, movement, and impacts of blooms. The forecast system also provides daily public condition reports. Forecasting methods vary based on the species and geographic area.

NOAA's Ecological Forecasting Services Roadmap: National Scale, Regional Delivery

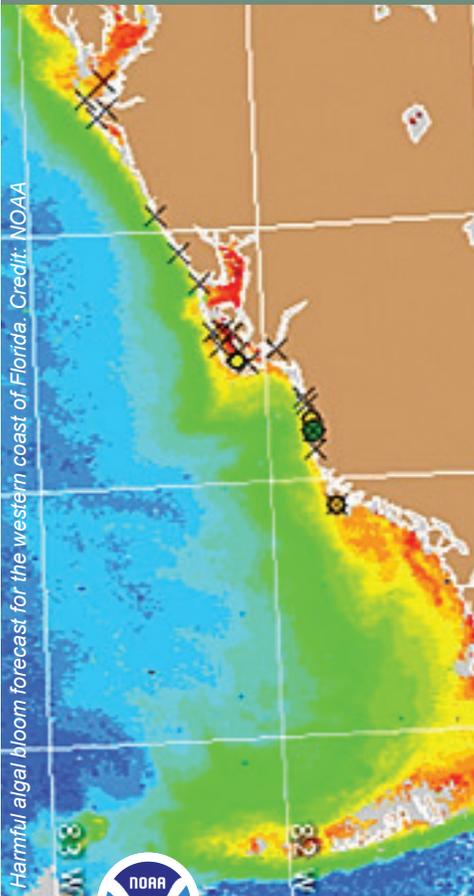
How will NOAA improve ecological forecasting?

NOAA's Ecological Forecasting Roadmap is a plan to deliver coordinated, accurate, and resource-efficient ecological forecast products. This longterm approach will allow us to meet our key mandates tied to protecting life, property, and human health, while maintaining our role as stewards of the environment.

Collaborative, systematic, ecological forecasts will build upon NOAA's ongoing investments in scientific understanding of ecosystem structure, dynamics, and functioning; advances in observational, modeling, and computational infrastructure; and experience in operational forecasting.

Can a national approach work regionally?

We recognize that what is appropriate for water quality managers in one region may not be appropriate in another. However, nationwide consistency is critical for success. That's why the Roadmap supports a consistent, national protocol for ecological forecasts while allowing the agency to continue to target development and implementation of region-specific forecasts.



Harmful algal bloom forecast for the western coast of Florida. Credit: NOAA



Major Focus Areas

Have priority areas been identified?

NOAA has historically developed and delivered ecological forecasts on an ad hoc basis, with various parts of the agency working somewhat independently of each other. While this approach has resulted in isolated success, it has not always offered the sustained outcomes needed for reliable decision making.

The Ecological Forecasting Roadmap addresses this issue by accounting for needs expressed by stakeholders; how mature NOAA's capacity is in a particular area; and national significance. This analysis resulted in identification of three priorities: **harmful algal blooms**; **hypoxia** (sometimes called "dead zones"); and **pathogens** (organisms that cause disease). The Roadmap offers a more coordinated and systematic approach to ecological forecasts needed by the nation.

NOAA's Customers Play a Key Role in Developing New Forecasts

Who are NOAA's customers?

Do you use NOAA products and services? Then YOU are a NOAA customer! Here are some examples of our key customers: federal agencies • water quality managers at the state, tribal and local level • commercial and recreational fishers • seafood restaurants and markets • coastal tourism officials • public health officials • and of course, the people who live, work and recreate in coastal areas.

What role do NOAA's customers play?

We rely on customer input in order to develop and prioritize forecasts with limited resources. As part of our Roadmap activities, we plan to continually engage in dialogue with a broad range of customers to:

- help guide research and development of forecasts,
- identify appropriate delivery mechanisms,
- establish requirements of forecast skill, and
- receive feedback to improve our products and services.

We have gathered input from many of our customers for certain ocean health threats such as HABs and hypoxia. Input from a wide-range of customers will continue to be an integral part of our future efforts.

*"Our job is to build an understanding of the Earth, the atmosphere, and the oceans and to transform that understanding into critical **environmental intelligence**: timely, actionable information, developed from reliable and authoritative science, that gives us foresight about future conditions."*

- Dr. Kathy Sullivan
NOAA Administrator



Credit: NOAA

Harmful Algal Blooms

Economic impacts of coastal HAB events in the United States have been estimated to be \$82 million/year. The majority of these impacts have been in the public health and commercial fisheries sectors.

Hypoxia

The largest hypoxic zone affecting the United States, and the second largest hypoxic zone worldwide, occurs in the northern Gulf of Mexico. Its greatest extent measured 22,000 square kilometers during the summer of 2002, roughly the size of the state of Massachusetts.

Pathogens

In 2011, 43% of the beaches that were monitored for pathogen pollution in the United States had at least one advisory (a recommendation to avoid swimming) or closing.

Case Study: Ecoforecasting Prevents Thousands from Getting Sick in Texas

In March of 2008, an unprecedented abundance of the algae, *Dinophysis acuminata*, was detected in the waters of Port Aransas, TX. This type of bloom produces a toxin called okadaic acid that can accumulate in shellfish and cause diarrhetic shellfish poisoning (DSP) in human consumers. *D. acuminata* has never been seen at such concentrated bloom levels in this region.

The bloom was first detected by scientists from Texas A&M University, who were demonstrating a new detection technology, supported by NOAA and partners.

The Texas Department of State Health Services closed Aransas, Corpus Christi, and Copano Bays to shellfish harvesting. Later in the month, six other bays and estuaries along the coast were closed. The early detection of this species protected human health by allowing managers to issue a timely recall of potentially contaminated oysters, clams, and mussels from the Fulton Oysterfest, a local oyster festival.

NOAA scientists also modeled potential transport of the bloom to nearby regions to help the state develop monitoring and sampling strategies to minimize negative effects on the economy and health of local residents.



Credit: Texas Parks and Wildlife Department



State public health officials and resource managers train in methods to detect pathogens and harmful algae species. Credit: NOAA

Partnerships are Key to NOAA's Success

It is essential for NOAA to take full advantage of our network of partners to make the most of available expertise and assets. Successful ecoforecasting depends upon continued close work with federal, state, and local partners to develop a shared vision of roles and responsibilities. This includes building on existing lines of communications and partnerships with other federal agencies; the Coastal States Organization; state coastal, natural resource, environmental, and public health agencies; multi-state entities; and multi-agency task forces. Simultaneously, we need to build upon relevant research and development activities in academic institutions, non-governmental organizations, and industry.

Learn More

NOAA's Ecological Forecasting

oceanservice.noaa.gov/ecoforecasting/

NOAA Harmful Algal Bloom Operational Forecast System

tidesandcurrents.noaa.gov/hab/

Hypoxia Watch

www.ncddc.noaa.gov/hypoxia/

Ecoforecasting Overview

<http://oceanservice.noaa.gov/observations/ecoforecast/>

